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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.8

Brazil

HYDROMETALLURGY OF ZINC ORES WITH HIGH SILICA CONTENT SOLUBLE IN ACID, PARTICULARLY THOSE OF SILICATE TYPE

By Hugo Lodewijk RADINC,
Chemical Engineer,

and Pedro PEDRINI,
Economist

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HYDROMETALLURGY OF ZINC ORES WITH HIGH SILICA CONTENT SOLUBLE IN ACID, PARTICULARLY THOSE OF SILICATE TYPE

by Hugo Lodewijk Radion, Chemical Engineer,
Pedro Pedrini, Economist

1. Zinc carbonate and silicate ores constitute important deposits in certain regions. Zinc silicate ores are the only ones found so far in Brazil in sufficient quantity to justify the setting up of a zinc metallurgy.

2. It is impracticable to make use of zinc silicate ores by pyrometallurgy. Their reducibility is intrinsically very low, as E. C. Truesdale and W.K. Warung demonstrate in their fundamental investigation, Relative Rates of Reactions Involved in Reduction of Zinc Ores, Metals Technology (AIME), April (1941). That is why special processes have been developed to make use of such ores, processes aiming to obtain zinc oxide and not metallic zinc, such as those of Wethrill and Waelz.

3. Such silicate ores also present a serious problem when an effort is made to use them by hydrometallurgical processes, as a result of the formation of silicic acid during their lixiviation by acids. We quote from page 16 of the work by George D. Van Arsdale, Hydrometallurgy of Base Metals, McGraw-Hill Book Co., Inc. (1953):

> "As far as is known, no ores of zinc are leached directly to recover the metal."

And again on page 17 he says:

> "Carbonate and silicate ores have yet to be handled with complete success and perhaps a leaching method will some day prove suitable for treating them."

4. Difficulties caused by formation of silicic acid during lixiviation are not exclusive of silicate ores. Many concentrates of ustulate sphalerite have a silica content, soluble in sulphuric acid, of up to 2 or 3 per cent. It may derive from silicates originally existing in the ore and not separated in the process of concentration of the sulphide or the silicates may be formed during ustulation of a concentrate containing a quartziferous gangue. In low concentrations the silicic acid greatly diminishes the speed of sedimentation of the solids in a lixiviation suspension, and markedly obstructs the pores of filtering surfaces, making necessary installations with large filtration surfaces. When the percentage of silica is higher, however, as in the case with minerals abundant in Brazil in the regions of Vazante and Januária, State of Minas Gerais, where the content of silica soluble in sulphuric acid is in the order of 10 to 25 percent of SiO_2, the suspensions obtained in lixiviation, aside from not being filtrable, form a kind of jelly which makes it impossible to recover the zinc made soluble during the leaching.

5. An example of the treatment of sulphide ores containing a small proportion of silicates soluble in acid is that of the Rhodesia-Broken Hill Development Co. In order to eliminate the solubilized silica they promote the oxidation of part of the Fe II with manganese ore and the rest with manganese bioxide from the electrolytic tanks. Then as a result of a very slow and careful neutralization, the temperature being controlled at about 70° C and kept there while the suspension is agitated, the iron precipitates in the form of iron hydroxide III and the silica is transformed into a gel of granular form. A test is then made to see if the silica is properly granulated; 250 ml of the suspension is filtered through a Buchner funnel of 10 cm diameter, and the filtration time is noted until the cake shows cracks. If the filtration time is less than 8 minutes the suspension is considered properly granulated; if longer, agitation is continued until the filtration test comes out satisfactorily.

6. When lixiviation is carried out on zinc ores containing 58.4% of ZnO and 24.7% of SiO_2 (95% of silica content being soluble in sulphuric acid at 100 g/l), use of the above-described technique for elimination of silica provides suspensions that require at least 1.5 hours for filtration of 250 ml. The time is excessively long; and it takes about 4 hours to filter the same volume when the Fe III ion is not used to coagulate the silica.

7. Assuming that the silicic acid formed in the lixiviation is in the form of a colloid solution with the particles negatively charged, we gave thought to the use of ions other than iron which would show a high flocculating power, whose sulphurates would be soluble in heated solutions of zinc sulphate without decomposition or hydrolysis, and which could easily be obtained industrially at low cost. Aluminum being the element most nearly meeting these conditions, we decided to use it in our experiments.

8. We found that the use of quantities of aluminum sulphate in the proportion of 7 to 10.5 per cent of Al_2O_3 in relation to the soluble silica of the ore, and by attacking the said ore with solutions of sulphuric acid at 50 g/l, extraordinarily rapid filtrations were obtained, although the volumes of the filtration cakes were relatively large on the order of 5 kg of moist cake for each kg of zinc ore. The filtration times of the samples, under conditions as described in paragraph 6, were under 2 minutes.

9. The inconvenience caused by the large volume of the cake was removed by adoption of a new technique in leaching the ore. It was found experimentally that, upon addition of sulphuric acid solution to a lixiviated suspension already totally neutralized in which the silica was already coagulated, an appreciable sedimentation of the solids in the suspension was obtained. The filtration cake was quite reduced in volume, although the filtration time was relatively long when an acid filtration medium was used. We also observed that the silica already coagulated did not again enter into solution.

10. Proceeding from this observation we finally developed a new technique of lixiviation. We now acidulated a lixiviated suspension, already neutralized, with a charge of sulphuric acid solution equal to that used in the first lixiviation, and later neutralized this charge of acid with an equivalent charge of ore. A charge of acid was again poured over the suspension thus obtained, and this charge then neutralized with another of ore. Half an hour was allowed to pass between successive additions of acid or ore. Before carrying out the fourth addition of acid in the lixiviation tank, a third of the volume of lixiviated suspension was removed and sent on for filtration. We continued in this way in the same sequence with alternate additions of acid and ore, and before each addition of acid we took out a third of the volume of the lixiviated suspension in the tank. With each charge of acid there was added, simultaneously, a certain quantity of aluminum sulphate.

11. A number of interesting facts were observed. The suspension became more fluid, although there was little change in fluidity from the fourth charge on. Sedimentation was progressively greater and faster as the number of operations increased, and was stabilized from the eighth on. The volume of precipitate diminished with the sequence of operations, tending toward a minimum limit depending on the quantity of aluminum sulphate used and also being somewhat influenced by the temperature; it varied around 1.5 kg of moist cake per kg of ore. Retention of soluble zinc in the filtration cakes was very low when the cakes were washed with displacements on the order of 150 to 200 per cent. With each addition of acid the aluminum already precipitated in a previous operation again entered into solution in a proportion of 60%; this of course made it possible to reduce the quantity of aluminum sulphate necessary to maintain a given speed of filtration and weight of the cake.

12. The factory which is being built in the municipio of Itaguai, state of Rio de Janeiro, with financing by the National Bank of Economic Development, for zinc metallurgy by the hydrometallurgical process, is based on the lixiviation technique described above. The said process has been tested in a pilot plant that has been in operation for almost five years, producing 200 kg of zinc per day using calamine from Vazante and willemite from Januária. The recovery of soluble zinc contained in the filtration cake has been on the average above 96%, with a washing displacement on the order of 150 to 200% and a filtering surface of 1 m^2 per ton of zinc per day. The new lixiviation technique has been used, but conventional processes have been used for the subsequent purification of the solution of zinc sulphate obtained, before proceeding to its electrolysis.

13. Once the scientific solution had been found in the laboratory, a pilot plant was set up to test whether the new invention was practicable as well as economically sound.

14. Once the results obtained in the laboratory were confirmed and the viability of the new production process demonstrated in practice, it was decided that the zinc plant should have a daily capacity of 20 tons, that is, 7200 tons annually of zinc in ingots.

15. During the phase of installation, construction of the plant will have a substantial impact on the economy of the Guanabara-State of Rio de Janeiro region, since the project will be largely based on local factors. A certain amount of machinery must be imported from São Paulo, but nothing from abroad.

16. As to the impact of the undertaking when it goes into operation, some of its beneficial effects on the regional and national economy are given below. As regards the regional economy, account should be taken of the economy of the Guanabara-State of Rio de Janeiro region and of the economy of the region which the zinc ore will come from.

17. As to the first region - where the plant is located - the following effects may be listed:

i) Use of unskilled labour from the rural sector - 65 labourers - with consequent improvement of their living standards because of higher wages and greater productivity; 41 skilled workers will also be used.

ii) Benefits to the finances of the Município of Itaguai because of increased receipts from taxes applying to the new industry, and indirectly through development of other activities.

iii) Increase of state revenues, in the amount of Cr$ 86.400 thousand per year through collection of the Tax on Sales and Consignments and the Electrification Fund. This does not include the revenue derived from increased commercial transactions resulting from increased demand for goods of immediate consumption; this will be equivalent to the greater part of the annual payroll (Cr$ 60 million).

18. As to the second region mentioned above - the municípios of Vazante and Januária - the benefits indicated can be extended to include the establishment there of mining activity on a definitive and continuous basis. The socio-economic effects will be of major significance, as this is one of the most underdeveloped regions in the country; even farming and cattle-raising have not yet succeeded in gaining a systematic foothold there on account of bad climate, irregular rains and low soil fertility.

19. If this zinc ore is made use of - it never has been and certainly never would be were it not for the technical innovation adopted - it will represent a flow into the said region of some Cr$ 30 million annually, an amount corresponding to the wages to be paid to workers in the mines.

20. As to the impact on the national economy as a whole, aside from the direct effect on income (an additional net value of Cr$ 800 million a year) and its reflex effects on the regional economies as already indicated, the following facts should also be considered:

i) Increase of federal revenue through Income Tax and Additonal Income Tax; the amount will be approximately Cr$ 150 million annually.

ii) Training in advance of the workers recruited for the plant, thus improving national know-how without spending a single unit of exchange and without importing technicians.

iii) By virtue of having carried out research, experimentation and investment to discover the new production process, the plant has contributed to increase the stimulus to the small class of Brazilian scientists, and has also given publicity abroad to our inventive and technical capacity.

iv) Use of national mineral resources: zinc ore 24,000, bauxite 396, manganese ore 230 and limestone 180 tons/year.

v) The factory by production of zinc in ingots will provide Brazil with a net annual saving in exchange, on the average, of approximately 2 million dollars.

21. Just as all the raw materials to be used for production of this metal are of domestic origin, so all equipment and installations will be acquired in Brazil.

22. Consequently, the project that is being carried out represents a promising milestone on the road to Brazilian economic development. We are pleased to point out that the whole project, from the conception and research to develop the new productive process to the technical specifications and designs of special equipment, has been under the charge of Brazilian technicians.

23. In addition to marking the beginning of zinc metallurgy in Brazil, the project also demonstrates the flowering in this country of a new attitude in approaching scientific research and technical problems, thus contributing to the beginning of a process of replacing imported know-how.

24. The apparent average consumption of zinc in ingots in Brazil for the 3-year period 1958/60 was 25,412 tons. Consumption tends to expand rapidly, as seen by the fact that in the 3-year period 1948/50, only 10 years earlier, the annual average was no more than 8550 tons. It is to be expected that demand for zinc will continue to increase in the coming years, perhaps at an even faster rate than in the past, in virtue of the accelerated rate of national development.

25. It is estimated that in 1963, when the plant is scheduled to begin production, the demand for zinc in ingots in the Brazilian market will come close to 35 thousand tons a year. It is thus clear that the project has ample possibilities of success, since it can count from the first on a market 5 times as great as the production planned for the initial period.

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SUMMARY

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Brazil

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HYDROMETALLURGY OF ZINC ORES WITH HIGH SILICA CONTENT SOLUBLE IN ACID, PARTICULARLY THOSE OF SILICATE TYPE

By

Hugo Lodewijk Radino, Chemical Engineer

Pedro Pedrini, Economist

1. The present paper deals with installation of zinc metallurgy in Brazil by the use of oxidised zinc ores of silicate type as raw material.

2. This type of ore is the only one so far encountered in Brazil in sufficient quantities to justify the organization of zinc metallurgy.

3. The authors point out the difficulties encountered up to now in making use of zinc silicate ores, whether by pyro- or hydrometallurgy. For pyrometallurgy this is due to their intrinsically low reducibility; for hydrometallurgy it is by reason of difficulties in filtration due to the formation of silicic acid upon lixiviation of the ore with solutions of sulphuric acid.

4. In zinc hydrometallurgy on the basis of non-oxidized, sulphide-type ores containing comparatively much less silica soluble in acid solutions, use is made of the ferric ion as an agent to transform the silica, in solution, into a gel of granular form that is easy to filter. This flocculating agent is entirely ineffective in the case of silicata ores, the content of silica soluble in acid being much higher.

5. We found that by the use of quantities of aluminum sulphate in the proportion of 7 to 10.5 per cent of Al_2O_3 in relation to the soluble silica of the ore, and by attacking the said ore with solutions of sulphuric acid at 50 g/l, extraordinarily rapid filtrations were obtained, although the volumes of the filtration cakes were relatively large—in the order of 5 kg of moist cake for each kg of zinc ore.

6. The inconvenience caused by the large volume of the cake was removed by adoption of a new technique in leaching the ore. We now acidulated a lixiviated suspension, already neutralized, with a charge of sulphuric acid solution equal to that used in the first lixiviation, and later neutralized this charge of acid with an equivalent charge of ore. This operation was repeated successively. Before the fourth and subsequent additions of acid, a third of the volume of the suspension was removed from the lixiviation tank and sent on for filtration. With each charge of acid a quantity of aluminum sulphate was added. In this way extraordinary filtration results were obtained.

7. The factory which is being built in the municipio of Itaguai, State of Rio de Janeiro, for zinc metallurgy by the hydrometallurgical process, is based on the lixiviation technique described above. The said process has been tested in a pilot plant that has been in operation for almost five years, producing 200 kg of zinc per day using calamine from Vazante and willemite from Januaria. The recovery of soluble zinc contained in the

filtration cake has been on the average above 96%, with a washing displacement on the order of 150 to 200 per cent and a filtering surface of 1 m^2 per ton of zinc per day.

8. During the phase of installation, construction of the plant will have a substantial impact on the economy of the Guanabara-State of Rio de Janeiro region, since the project will be largely based on local factors. A certain amount of machinery must be imported from São Paulo, but nothing from abroad.

9. As to its impact on the national economy as a whole when the plant goes into operation, aside from the direct effect on income (an additional net value of Cr$ 800 million a year) and its reflex effects on the regional economies where the ore deposits are located, the following facts should be considered:

i) Increase of federal revenues by approximately Cr$ 150 million annually.

ii) The workers recruited for the plant are being trained in the factory, thus contributing to improve national know-how.

iii) By virture of having carried out research, experimentation and investment to discover the new production process, the factory has contributed to increase the stimulus to the small class of Brazilian scientists, and has also given publicity abroad to our inventive and technical capacity.

iv) Use of national mineral resources.

v) By producing zinc in ingots, the factory will provide Brazil with a net annual saving in exchange, on the average, of approximately 2 million dollars.

10. The project that is being carried out represents a promising milestone on the road to Brazilian economic development. It also demonstrated the flowering in this country of a new attitude in approaching scientific research and technical problems, thus contributing to the beginning of a process of replacing imported know-how.

11. The apparent average consumption of zinc in ingots in Brazil for the 3-year period 1958/60 was 25,412 tons. It is estimated that in 1963, when the plant is scheduled to begin production, the demand for zinc in ingots in the Brazilian market will come close to 35 thousand tons a year.

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CONFÉRENCE DES NATIONS UNIES
SUR L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE
DANS L'INTÉRÊT DES RÉGIONS PEU DÉVELOPPÉES

Point de l'ordre du jour : D.4

France

INTERET DE L'IRRADIATION DES PRODUITS AGRICOLES ET ALIMENTAIRES DANS LES REGIONS PEU DEVELOPPEES

Par Pierre VIDAL,
"CONSERVATOME", Lyon

Les mémoires rédigés à l'intention de la Conférence des Nations Unies sur l'application de la science et de la technique dans l'intérêt des régions peu développées sont des documents de travail. Ils sont publiés tels qu'ils ont été présentés et les assertions et opinions qu'ils contiennent sont celles de leurs auteurs.

NOTES

1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

2. Les mémoires choisis pour être présentés en séance spéciale pourront être obtenus à la Conférence dans l'une seulement de ces langues officielles.

3. Les résumés qui ont été rédigés pour tous les mémoires par les auteurs de ceux-ci pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

4. Préalablement à la Conférence, les mémoires et les résumés ne feront pas l'objet d'une distribution générale mais d'un tirage restreint destiné aux délégations des gouvernements et autres participants officiels. La publication et la distribution générale des actes de la Conférence s'effectueront conformément aux règles et pratiques agréées par le Comité des publications des Nations Unies.

INTERET DE LA RADIOEXPOSITION DES DENREES ALIMENTAIRES DANS LEUR CONSERVATION ET LEUR DISTRIBUTION

Il n'est pas de jour où les journaux, les Revues et les Conférenciers, dans différents domaines, attirent l'attention sur l'accroissement de la population du globe, et la nécessité d'accroître la quantité de denrées alimentaires nécessaires à cet accroissement de population. De même, est attirée l'attention du globe sur l'état de sous alimentation, plus ou moins accentuée, d'une partie de la population mondiale. La population du globe a dépassé le chiffre de 3 milliards au deuxième semestre 1961, soit un accroissement de près de 500 millions depuis 1950 et il est prévu 4 milliards dans 20 ans au rythme d'accroissement d'environ 48 millions par an.

Actuellement, la moitié de la population est sous alimentée et le problème qui se pose est double :

- assurer une alimentation normale à la population actuelle,

- assurer une alimentation normale à l'accroissement de population.

Si certains estimaient encore il y a 5 ans que la production agricole serait entièrement consommée par la population toujours croissante, d'autres émettent maintenant l'avis que la production agricole augmente plus vite que l'accroissement de la population.

Compte tenu de ces observations divergentes l'une ou l'autre opinion admet explicitement ou implicitement :

- l'amélioration de la production,
- l'amélioration de la conservation,
- l'amélioration de la distribution.

Dans ces trois domaines l'irradiation ou radioexposition contribuera d'une façon importante à l'amélioration de chacun.

Nos recherches entreprises depuis un certain nombre d'années dans nos laboratoires, les études des possibilités industrielles étudiées dans le Centre Lyonnais d'Applications Atomiques de DAGNEUX où une importante installation à Cobalt 60 pouvant contenir 1 million de Curies est en cours d'exploitation et de développement permettent de réaliser l'importance du traitement de radioexposition dans les domaines ci-dessus.

Intérêt et avantages de l'irradiation des denrées alimentaires -

Nous ne rappellerons ici que les résultats déjà tangibles que nous avons obtenus et développés dans nos recherches et susceptibles d'applications pratiques immédiates. De nombreux autres sont en cours de développement mais nécessitent des recherches complémentaires tant techniques que technologiques.

Amélioration de la production agricole - Nos recherches dans ce domaine ont porté sur différents points mais surtout sur l'amélioration des cultures. Nous ne le développerons pas ici.

Conservation des denrées alimentaires - L'homme dispose d'un certain nombre de procédés de conservation qu'il a acquis au travers des âges : le sèchage, le fumage, le salage, l'appertisation, la réfrigération en sont les principaux. Il faut reconnaître que la plupart n'ont pas apporté une solution complète au problème de la conservation. Ainsi, l'appertisation est parfois trop onéreuse pour certains produits, pour d'autres elle n'est pas suffisante. La réfrigération (réfrigération ou congélation) n'est pas toujours applicable, parfois elle a une durée limitée d'application, d'autres fois elle est trop onéreuse. En particulier, si elle est la solution pour la distribution dans les pays développés, sa durée limitée et les importants investissements nécessités rendent parfois impossible l'application de la chaîne du froid dans les pays chauds ou peu développés.

La radioexposition, dans certains cas, suppléera ces procédés de conservation, dans d'autres elle sera utilisée conjointement avec eux et dans certains elle ne pourra les remplacer. En fait, nous nous trouvons devant un nouveau procédé de conservation qui, comme les autres, n'est pas universel.

Conservation des tubercules, bulbes et rizhomes -

Dans de nombreux pays les tubercules, bulbes et rizhomes constituent une part importante de l'alimentation de la population. Leur conservation est limitée dans le temps et après une certaine période appelée "dormance", leur évolution part, d'où perte de leurs qualités et de leur valeur alimentaire et conservation terminée. Cette conservation est encore plus difficile quand il s'agit de les conserver dans des climats chauds ou humides ou les deux à la fois. Différents moyens ont fait l'objet d'études en vue d'augmenter cette durée de conservation. Techniquement ils n'ont pas donné satisfaction et la plupart du temps le procédé était trop coûteux pour le produit (appertisation) ou trop coûteux et limité dans le temps (froid) ou coûteux et non pratique.

Dans ces conditions, ces produits agricoles présentent au cours d'une année une période d'absence ou de rareté et de prix élevé. Ceci a des répercussions importantes tant politiques qu'économiques et sociales. Le problème ne peut être résolu par une planification de la production car le rendement à l'hectare est imprévisible d'une saison à l'autre.

La radioexposition apporte une solution élégante à ce problème. Des doses de rayonnements comprises entre 8 000 et 12 000 rads permettent d'arrêter définitivement la germination des tubercules, bulbes et rhizomes et permet la conservation d'une production à une autre. Pour certains la conservation peut encore être plus prolongée ce qui peut présenter dans certains cas des avantages supplémentaires. Il convient, dans ce cas, d'avoir une hygrométrie suffisante pour éviter une dessication qui peut commercialement dévaloriser le produit bien qu'il conserve sa valeur et d'éviter une hygrométrie trop importante sans ventilation. En général une hygrométrie de 85% est la plus recommandée.

Les tubercules, bulbes, rhizomes radioexposés peuvent être ainsi conservés et transportés sous tout climat aux moindres frais.

Les recherches ont montré que la qualité des produits n'est pas modifiée et que la valeur nutritive est pratiquement inchangée. Pour les produits non radioexposés, dès que le phénomène de germination se développe, la qualité et la valeur nutritive décroissent rapidement.

La radioexposition assure une conservation excellente et permet d'éviter la perte de quantités importantes de ces tubercules, bulbes, rhizomes, de réaliser un approvisionnement continu du consommateur entre deux productions, de régulariser le cours de ces produits : ce que les autres procédés de conservation actuellement utilisés ne permettent pas.

Le coût du traitement est bas, les études faites sur les pommes de terre montrent qu'il se situe entre 9 à 12 NF la tonne traitée pour une capacité de l'ordre de 20 tonnes/heure et en fonction de 4 mois par an.

Le prix du Cobalt 60 doit baisser et, constituant une part importante du prix du traitement, ce dernier baissera également.

Dans ce domaine, les installations de radioexposition, sauf cas particulier, utiliseraient le rayonnement Gamma, produit par des radioisotopes artificiels (Co 60, Cs 137). Les plans de telles installations sont établis et une installation de recherches, montrant ce que seront ces installations, fonctionne à DAGNEUX en FRANCE.

Destruction des insectes et parasites -

La présence d'insectes qui détruisent rapidement les denrées alimentaires et de parasites qui risquent d'infecter l'homme est un problème pour la solution duquel on peut dire qu'en général il n'a pas été entrevu de solution pratique, efficace, et élégante.

Dans de nombreux pays, et en particulier dans les pays chauds, le développement des insectes est tel que les céréales entre autres sont l'objet de dégâts très importants avec toutes les conséquences : difficultés d'approvisionnement et augmentation du prix des céréales livrées.

On connaît plus de trente maladies qui peuvent être communiquées à l'homme par l'ingestion de viandes ou de produits marins. Vers et insectes parasites infestent encore des dizaines de millions d'invidus par suite d'absorption d'aliments contaminés : viandes, poissons, crustacés. La lutte contre ces parasites est très difficile et on peut dire souvent presque impossible, sauf en détruisant ou tout au moins en dénaturant grandement les qualités des produits.

En ce qui concerne les insectes, différents traitements sont effectués par des produits chimiques principalement mais ils sont difficiles à appliquer, parfois onéreux et partiellement efficaces. Les traitements actuels sont de plus en plus inopérants à mesure que leur application a lieu dans des régions à climat de plus en plus chaud. Les pertes peuvent atteindre, par exemple dans les céréales, 60 à 70%. Les expériences réalisées depuis plusieurs années ont montré que la radioexposition des céréales et de tout produit agricole séché permet leur désinsectisation. Ces recherches ont montré qu'il n'était pas nécessaire

de tuer ces insectes en utilisant des doses élevées, mais simplement de les rendre stériles. Ce but est atteint avec des doses très faibles de l'ordre pratique de 20 000 à 30 000 rads. Avec ces doses la prolifération des insectes est arrêtée par le fait que l'insecte, à ses différents stades d'évolution, est rendu stérile.

Les études ont montré que cette radioexposition peut être réalisée soit par utilisation de faisceaux d'électrons émis par des accélérateurs, soit par utilisation de rayonnements gamma. Le choix dépendra du lieu de traitement et de l'ensemble du problème à résoudre. Le coût de l'opération peut être situé actuellement à 0,75 à 2,20 NF la tonne et baissera certainement dans les années à venir. Etant donné les pertes importantes de céréales et de produits végétaux secs, principalement dans les pays chauds, ce prix est minime.

La technologie des installations est étudiée et la réalisation pratique peut intervenir. Les débits peuvent atteindre 200 T/ Heure.

D'autres produits, comme les épices, peuvent être traités avec succès et également les poissons séchés qui constituent la base de l'alimentation de nombreuses populations. Souvent ces poissons séchés sont attaqués par des insectes; la radioexposition permettra de leur assurer une meilleure conservation.

En ce qui concerne les vers et parasites, la radioexposition est le seul procédé qui peut donner des résultats tangibles tout en conservant aux denrées leurs qualités et leurs valeurs alimentaires. Le nombre des problèmes est très élevé mais deux cas concrets montreront mieux les immenses possibilités offertes. Les doses appliquées peuvent être de l'ordre de 10 000 à 50 000 rads, ou de 300 000 à 500 000 rads.

La trichine du porc est plus ou moins répandue et atteint un grand nombre d'humains. Des doses de 30 000 à 50 000 rads la détruisent, mais des doses de l'ordre de 15 000 rads, sans tuer la trichine, empêchent son développement ultérieur. Tous les moyens et procédés de lutte n'ont pu arriver à un résultat jusqu'à ce jour et la radioexposition des viandes de porc apparaît comme le seul procédé techniquement réalisable et économiquement rentable. Ce procédé peut être appliqué pour de nombreux vers et parasites pour lesquels n'existent actuellement aucun procédé de lutte efficace et valable.

Dans le domaine des bactéries, la radioexposition apporte également une solution aux problèmes de leur destruction. Par exemple, les salmonellas sont responsables chaque année de la mort d'un nombre plus ou moins important de personnes. Entre autres, les salmonellas se rencontrent dans les oeufs congelés, ou oeufs en poudre qui sont utilisés dans de nombreuses industries

alimentaires. L'utilisation de la chaleur est difficilement réalisable pour le traitement. Dans certains cas, la contamination peut atteindre et dépasser 20% des stocks.

La radioexposition à des doses de 350 000 à 450 000 rads permet la destruction des salmonellas dans les oeufs congelés. Une dose de 0,5 MR offre donc une garantie suffisante. L'emploi du procédé serait déjà justifié par le fait qu'il est le seul à pouvoir donner ce résultat de préserver des vies humaines. Mais en plus, le coût du traitement est rentable et se situe entre 0,08 à 0,11 NF la tonne pour un produit dont le coût est de l'ordre de 3 500 NF la tonne.

L'installation de traitement utilisera les rayonnements gamma émis par une source de radioisotopes - (Co 60 ou Cs 137). Le coût du traitement doit pouvoir baisser d'environ 20 à 30% quand le prix des radioisotopes baissera.

Dans ce domaine de lutte contre les insectes, bactéries,vers, parasites, la radioexposition apporte un moyen de préservation inexistant à l'heure actuelle et à un coût très rentable. Cette technique sera d'une importance encore plus primordiale dans les pays à climats chauds et en voie de développement.

Radiopasteurisation - Cette opération est la même que celle effectuée par la chaleur et appelée pasteurisation. Les résultats sont comparables : destruction incomplète des microorganismes. La pasteurisation par la chaleur apporte une élévation importante de la température du produit, la radiopasteurisation n'apporte aucune élévation sensible de la température du produit.

La radiopasteurisation utilise des doses s'étageant d'environ 100 000 rads à 7 à 800 000 rads. Elle est parfois utilisée avec d'autres procédés de conservation : la chaleur (permettant ainsi d'utiliser à la fois des températures et des doses de rayonnement plus faibles,) le salage, le fumage, pour améliorer la durée de conservation, la réfrigération pour prolonger la durée de conservation sous le froid.

Dans ce domaine très vaste et qui sera celui qui recevra au début les plus larges applications toutes les techniques et les technologies ne sont pas encore connues.

Fruits frais - Un certain nombre de fruits frais de différentes origines montrent une augmentation sensible de leur durée de conservation après radiopasteurisation. Des doses de 350 000 à 500 000 rads sont nécessaires, la durée de conservation peut être doublée ou triplée. Cependant, ces doses agissent sur la texture des fruits et si la dose est relativement haute on peut avoir quelques changements de goût, d'ailleurs peu importants.

L'utilisation conjointe de la radiopasteurisation et de la réfrigération permet d'assurer une conservation de 2 à 5 fois celle sous réfrigération à +4°/+6°C en utilisant des doses de 150 000 à 200 000 rads. Avec ces techniques mises au point les fruits conservent leur fermeté et leur saveur. Nous avons pu l'appliquer principalement aux fraises, framboises, pêches à chair blanche et à chair jaune, abricots ananas, tomates.

Cette application de la radioexposition est très importante car elle s'applique à des fruits fragiles, de courte durée de production et de conservation difficile, elle doit avoir d'importantes répercussions au point de vue économique.

Produits de la mer - Les produits de la mer sont très périssables et il est très difficile d'en assurer une excellente et longue conservation même sous régime du froid. Les expériences réalisées dans ce domaine nous ont montré que l'utilisation conjointe de la radiopasteurisation à des doses comprises entre 150 000 rads et 600 000 rads et de la réfrigération de 0° à + 5°C permet d'augmenter considérablement la durée de conservation de nombreux poissons et crustacés. Les recherches doivent être continuées pour étudier pour les différents poissons les techniques les meilleures et la technologie à employer. Les résultats acquis auront une importance primordiale dans les pays ou le poisson est l'aliment de base car la radioexposition permettra également d'améliorer la conservation des poissons séchés ou salés ou fumés.

Semi-Conserves - De nombreuses fabrications à base de viande principalement ne sont pas stérilisées complètement car la qualité, la consistance, le goût du produit, la couleur changeraient complètement. De ce fait, la durée de ces semi-conserves est limitée dans le temps, même sous réfrigération. Parmi les multiples études il est apparu que le jambon était la "semi-conserve" qui offrait le plus de difficultés de conservation et dont l'intérêt d'améliorer la conservation était intéressant à tous les points de vue.

Les très nombreuses expériences que nous avons poursuivies depuis plusieurs années ont montré que l'irradiation permettait d'abaisser la température de cuisson des jambons, donc de leur assurer une meilleure consistance et un meilleur aspect et de leur assurer une conservation dépassant une année à la température ambiante. La dose à employer est de l'ordre de 500 000 rads.

Pour de nombreuses autres semi-conserves, le problème doit être mis à l'étude car, dans de nombreux cas, une solution pratique doit intervenir.

Dans ce domaine, on peut ranger les plats précuisinés cuits et certains produits de charcuterie. La conservation peut être augmentée par radiopasteurisation ou radiostérilisation, les doses variant de 600 000 à 2,5 megarads.

Dans ce domaine de la radiopasteurisation, les connaissances techniques et technologiques que nous avons acquises plus récemment et nos premières études économiques nous permettent d'envisager une opération rentable.

Techniques et installations à utiliser - La technologie étant au point, il convient d'étudier les installations permettant d'inclure ce nouveau procédé dans le circuit commercial et industriel. Depuis de nombreuses années nous étudions ce problème dans tous ses détails en vue de concevoir les installations nécessaires, d'examiner comment et où elles doivent être incluses dans le circuit de la production à la consommation et d'en poursuivre la réalisation. Il faut reconnaître que, dans ce domaine, comme dans celui de la mise au point des technologies de radioexposition, nous ne disposions que de très peu d'éléments au départ .

En l'état actuel de nos connaissances, les sources d'irradiation à utiliser se résument à deux :

1 - les accélérateurs d'électrons; les niveaux d'énergie à utiliser doivent être inférieurs à 8 MeV pour des raisons de sécurité et peut-être pourra-t-on atteindre 10 MeV. Les avantages de ces appareils qui ont fait d'immenses progrès techniques sont la sécurité car ils ne produisent aucune radiation quand ils ne sont pas en fonctionnement, la possibilité d'avoir des puissances au faisceau de plusieurs Kw et permettant d'importants débits de produits à traiter. L'inconvénient est la faible pénétration des élections et l'inégalité de répartition de doses dans la masse. Ces inconvénients peuvent d'ailleurs être diminués.

2 - les rayonnements gamma produits par les radioisotopes (Co 60 et Cs 137). Pour le moment d'autres sources de rayonnements gamma sont en cours d'étude (éléments usés d'uranium, boucle radioactive). Le Cobalt 60 est celui qui est actuellement le plus facile à obtenir et à mettre en oeuvre. Les avantages des rayonnements gamma résident dans leur grande pénétration de la matière avec une répartition meilleure et relative homogène, une irradiation continue sans risque d'interruption en cours de fonctionnement. Installation très robuste. En contre partie, des dangers accrus car l'émission de rayonnement est continue, installations plus volumineuses que celle d'un accélérateur d'électrons.

Après étude des avantages et inconvénients des deux appareillages nous nous sommes orientés vers l'étude et la construction d'une installation à rayonnements gamma en première phase, car elle nous permettait de réaliser les recherches et mises au point avec plus de facilités et moins de possibilités d'erreurs qu'un accélérateur d'électrons.

Industriellement, dans le domaine du traitement des denrées alimentaires, ce seront en général les installations à rayonnement gamma qui seront utilisées étant donné la grande pénétration du rayonnement. Dans certains cas, les accélérateurs d'électrons auront la préférence, en particulier, pour les produits de faible épaisseur ou en vrac. Cependant, dans certains cas l'un ou l'autre pourra être utilisé, celà dépendra des conditions particulières de l'emploi.

Quant au prix de revient de l'un ou de l'autre on peut dire qu'en l'état actuel on ne peut donner une indication définitive. Les prix des accélérateurs diminuent, leurs performances et leur qualité technique augmentent. Le prix du Cobalt 60 est encore élevé mais il est certain que, lorsque le problème sera pris industriellement, son prix baissera d'une façon importante.

Nous avons étudié d'excellents accélérateurs existants sur le marché. Le bloc d'irradiation gamma de Dagneux que nous avons conçu et réalisé et mis au point fonctionne depuis plus de deux ans. Il nous a permis d'acquérir les connaissances de technologie d'irradiation exposées précédemment. En outre, l'installation nous a fourni pour nos études et pour nos expériences les éléments nécessaires à la conception et à la construction d'installations industrielles de radioexposition à Cobalt 60. La souplesse de l'installation permet de porter les recherches dans tous les autres domaines industriels.

EN CONCLUSION; déjà pour plusieurs catégories de produits la technologie de radioexposition de ces produits, la conception des installations d'irradiation et les processus de conservation et de distribution sont connus.

La radioexposition sera un des éléments moteurs principaux qui fera progresser vers leurs solutions les problèmes d'alimentation des différents pays en améliorant ou en assurant la conservation de certains produits, en facilitant leur répartition et leur distribution, en régularisant et en abaissant leurs prix.

Ces avantages seront encore plus sensibles pour les régions chaudes et humides.

Il convient d'en prendre conscience et que les gouvernements portent une immédiate attention à ces nouvelles techniques.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item : D. 4

France

VALUE OF IRRADIATION OF AGRICULTURAL PRODUCE AND FOODSTUFFS IN LESS-DEVELOPED REGIONS

By Pierre VIDAL,
"CONSERVATOM",
Lyon, France

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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VALUE OF IRRADIATION OF AGRICULTURAL PRODUCE AND FOODSTUFFS IN LESS-DEVELOPED REGIONS.

D.4.

by Pierre Vidal, "Conservatom", Lyon, France.

GENERAL

The population of the world is about 2,900 million and a total of 4,000 million, at a rate of increase of around 48 million a year, is forecast within 20 years.

Almost half of the population is under-nourished. There are, therefore, three problems to be solved:

- improvement of production
- improvement of conservation
- improvement of distribution

The utilization of irradiation methods will provide an important contribution to the solution of these problems.

Advantages of the Irradiation of Foodstuffs.

1. Improvement of agricultural production.
2. Permanent conservation of produce, especially in sub-tropical or remote regions.
3. Retardation of the germination of nutritious bulbs and tubers with better and longer conservation.
4. Destruction of insects and parasites infesting foodstuffs.
5. Prolongation of the period of conservation in normal conditions.
6. Improvement in certain cases of present conservation processes and of the quality of the preserved products.
7. Considerable improvement of distribution and reduction in costs of the conserved products.

Application in Less Developed and Sub-Tropical Regions.

1. Improvement of production
   (a) in quantity
   (b) in quality

2. Consumption of local produce
   (a) improvement of conservation
   (b) improvement of distribution and consumption

3. Import and Export.

Techniques and Equipment

1. Preparatory equipment
2. Irradiation equipment (description of its functioning)
3. Various problems, packing, storing, transport, etc.

CONCLUSION

For a number of agricultural products and foodstuffs the technique of irradiation treatment and its commercialisation have already been studied and perfected. Irradiation has already enabled a very large part of the nutritional produce formerly wasted in the less developed or sub-tropical regions to be recovered by ensuring better distribution at only slightly higher cost.

The techniques are ready, they should be applied.

Irradiation will make it possible for the less developed or sub-tropical regions to develop their local production and thereby improve their level of living. By ensuring better conservation the people are better nourished and their well-being improved.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D. 13/D. 14

Economic Commission for Europe

TECHNICAL AND ECONOMIC ASPECTS OR THE INDUSTRIALIZATION OF BUILDING

By The Steel, Engineering and Housing Division,
Economic Commission for Europe

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TECHNICAL AND ECONOMIC ASPECTS OF THE INDUSTRIALIZATION OF BUILDING

by

The Steel, Engineering and Housing Division
Economic Commission for Europe

Introduction

1. Building materials are only one of the input factors entering into building activity in general, but certainly the most important single item of building costs. Building techniques, i.e. the different ways in which building materials and components are produced, selected, brought together and assembled in the erection of a given building, represent only one stage in the overall building process, which involves all the members of the building team from the client or the investor at one extreme to the user at the other. To reduce costs without impairing the quality of the building is the ultimate objective of technical and economic policies. These reductions can be achieved in many ways and at different stages of the building process; however, changes in building techniques are without doubt among the most effective means of bringing about an overall economy of building costs.

2. The complex problem of technical and economic policies in the field of building in general, and more particularly of house-building, have loomed large among the subjects to which the Housing Committee of the Economic Commission for Europe has devoted its attention over the last fifteen years. The present note will recall briefly some of the more recent studies carried out in this field under the aegis of the Committee and is based, strictly speaking, on European experience only. It is felt, however, that some of the problems to be faced and the approach followed in their solution may be of interest to developing countries; this particular question will be dealt with briefly in the last section of this paper.

The economic significance of residential and non-residential construction

3. Gross domestic fixed capital formation amounts to between 15 and 30 per cent of gross national product in a majority of European countries; approximately half of this goes into construction (residential building, non-residential building, civil engineering and other construction works). Housing alone represents anything between 25 and 50 per cent of gross capital formation in construction; in the majority of European countries, housing contributes by 35 to 45 per cent to gross capital formation in construction. This means that some 3 to 5 per cent of gross national product goes into investment in residential construction.

4. The general expansion of quantitative housing needs (accounted for by the backlog of neglect over the past generations, by rapid demographic growth and by the general trend towards urbanization), the constant and irreversible raising of qualitative standards and the general increase in building costs are all factors contributing towards making economies in building costs one of the main

problems of government housing policies and, in a sense, an important aspect of general economic development (1).

The Present level of house-building costs and the main factors affecting it

5. It is obvious that any systematic effort to reduce building costs must be based on thorough knowledge of their present level and on the main factors likely to affect their future development. However, it has been found that objective knowledge of actual building costs is comparatively scarce in the majority of European countries, for reasons inherent to the very nature of building activities which involve so many different partners, are spread over long periods of time and are generally difficult to be controlled.

6. Prices, i.e. the amount paid by the investors, are more easily recognizable and can be subject to statistical analysis; however, the value which can be derived from price studies is limited since prices, by their very nature, are affected by a variety of factors related to market conditions, in market economies, and to broad policy decisions, in planned economies.

7. In order to fill this gap and as part of its work programme, the Committee has undertaken several studies intended to throw light on the main components of actual house-building costs and on the factors affecting them. The work involved the collection and analysis of actual cost records on a number of building sites, broken down according to a common method.

8. Broadly speaking, the approach adopted was to have a double breakdown of building costs, one by main elements of cost (materials, labour, labour on costs, plant and machinery, site overheads, office overheads, taxes and profits), the other by elements of building, e.g. foundations, external walls, partitions, floors, roofs, etc., regrouped under three major headings: substructure, superstructure, finishes and equipment.

9. The results of the most recent enquiry carried out in this field by the Committee, covering some sixty building sites in nine European countries and a wide range of building materials and building methods - from purely traditional construction to the most recent examples of fullscale prefabrication of room-size wall and floor panels - are briefly recalled below.

10. Cost variations within a country, and sometimes even within categories of building, are as great as those between countries. This appears to be a significant characteristic of house-building activities in most European countries.

11. Taken as a whole and making allowance for the materials content of subcontractors' prices, building materials represent 60 per cent of the total cost of construction. In many cases the share of building materials in the total cost

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(1) The total number of dwellings built in 24 European countries reporting such data has grown from 3 million in 1953 to over 5½ million in 1961, i.e. a compound annual rate of increase of over 8 per cent. (See Annual Bulletin of Housing and Building Statistics in Europe, United Nations, Geneva). Assessment of objective housing requirements indicates that the number of dwellings built in Europe is likely to continue to increase steadily in the coming years if these needs have to be met at an adequate standard.

of the building is up to now only slightly affected by the transfer of operations from the building site to the factory. It would therefore appear that major economies in building costs can be achieved through a serious effort to reduce the cost and/or the quantities of materials, either on the site or at the factory.

12. The average direct labour cost in all the contracts included in the enquiry in approximately 22.5 per cent. Out of the fifty-five contracts for which data are available, thirty-nine have labour costs falling in the range of 15 to 30 per cent of the total cost. This figure is considerably lower than those considered as typical ten, or even five, years ago (1). With all the reservations to be attached to conclusions drawn from such a small sample, this appears to be a significant result of a general trend towards the reduction of the direct labour content of the building. This trend would appear even more significant if it is recalled that in the last five years, the indix of labour costs in almost all European countries has grown more rapidly than the index of material costs.

13. The general trend indicated above is consistent with the information obtained on total man-hours both on the building site and at the factory. Whereas only five years ago the figure of 20 man-hours per m^2 of gross floor area was rather unusal - except for some pilot or experimental schemes - the range seems now to be between 12 and 18 man-hours per m^2 of gross floor area, with an absolute minimum of 8.8 man-hours. The labour content appears to have been reduced substantially and there is ample indication that this trend is general and likely to continue, within obvious limits. Among the factors accounting for the reduction of labour costs and of man-hours, both on the building site and at the factory, mention should be made of better site organization, greater specialization of work, better and more frequent use of machinery and tools, the reduction in the quantity of materials used and other related aspects of the general trend towards the industrialization of building.

14. The relatively important share of building materials in the total cost sets definite limits to savings in over-all costs. In the three countries where large-panel construction has attained considerable proportions, the cost of construction by this method is in some cases substantially lower - from 10 to 20 per cent - than the cost of traditional construction. In all countries the use of large-panel construction considerably reduced the number of man-hours on site and sometimes total man-hours.

15. There appears to be little or no relationship between the actual expenditure on plant or machinery on site and the number of man-hours, the cost of labour or the total cost of building. However, the cost of plant and equipment is proportionally lower in large-panel construction than in construction by traditional methods, owing to the speeding-up of the building process and the consequent reduction of the time spent by the machines on the site, although the actual cost of the machines is greater.

16. No consistent relationship was found between the weight of materials and components and either the cost or the number of man-hours on site. It is only reasonable to assume that the reduction of the total weight of building materials and components to be handled at the factory or on the site should be conducive to savings in the number of man-hours, in labour costs, in the cost of machinery

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(1) See: "Government policies and the cost of building", E/ECE/364, 1959, part I, table II, p. 44.

needed for processing handling and transporting such components, as well as in the cost of storage at the factory and on site. However, the evidence available at present is not sufficient to measure the effect of this specific factor.

The production costs of selected building materials and components

17. The enquiry on house-building costs mentioned above confirmed that building materials represent up to and sometimes even more than 60 per cent of the total cost of construction. Attention was therefore devoted to the possibility of reducing this item of cost, and in particular to the benefits to be derived from mass production.

18. A special study was undertaken on the effect of repetition on the production cost of building materials and components, and more specifically on how production costs of selected components currently used in house construction may be and actually are reduced through a systematic limitation of the number of models produced or an increase in the length of production runs. The study was the first of its kind to be carried out on an international level, and, as far as building materials and products are concerned, has had very little precedent in national experience.

19. The problem of repetition, which is a very general one, is not restricted to the production of materials and components, but is relevant also to the design and even more so to the building operations on site; further enquiries shall be devoted to these important aspects of the industrialization of building. However, the provisional conclusions of the enquiry just concluded on the effect of repetition on the production costs of building materials and components, are briefly recalled below.

20. For factories producing several models in one production line, inventory costs are the main factor determining the optimum size of production runs of different models, taking into account the structure of demand and its influence on the variety of models and on the size of production runs of the different models.

21. Substantial cost reductions can be achieved by increasing the capacity of a factory and thus obtaining some of the benefits of mass production, even if the technique of production remains basically unchanged. The scope for cost reductions through the systematic limitation of the variety of models and the corresponding increase in the size of production runs depends on the nature of the product, on the organization and technology of the production process and on the scale of production in existing plants. The analysis show that in some cases the scope for cost reduction through limitation of the number of models is comparatively small, whereas in other cases, where limitation of the number of models will bring about a more efficient use of the capacity of the plant, an appreciable cost reduction will be possible. In some cases, limits to further cost reductions are set by the very structure of production costs; for instance, where materials costs represent more than half or even up to two-thirds of the total production cost.

22. A considerable increase in the scale of production often will entail completely new designs of products, which will be more suited to the specific requirements of mass production and will often allow great savings in materials. Such radical changes in design and in the processes of production have not been covered by the enquiry. But the effect of such changes on the reduction of costs is illustrated by the case of flush doors which are nowadays of better

and more regular quality and definitely cheaper than the traditional artisanal doors which they have replaced. The enquiry has brought to light the interconnexion between design and production, as well as the limitations of improvements which can be obtained within a given set of condition.

23. The structure of demand, together with its implications as far as the number, type and variety of models are concerned, has been assumed as one of the data to which the composition of output had to be adjusted. It was also recognized that both the production process and the production plant had been conceived and organized on the basis of a given pattern of demand. Changes in this pattern, which to a great and increasing extent, are within the realm of government policies in the field of standardization, would inevitably effect the corresponding production processes; in some cases they do and will no doubt continue to determine the setting up of entirely new plants with production techniques departing radically from those at present in use.

Initial cost and total cost: the problem of the lifetime of a building and of the expenditure on maintenance and repairs

24. So far only the initial cost of a building has been taken into account. But whatever the expected economic or social life of a building may be, some periodic expenditure will be required to maintain it in conditions suitable for the use for which it has been designed. Unfortunately, in the great majority of European countries, the sources of capital for new construction and the organs responsible for spending them are so far considered separately from the sums devoted to the maintenance and repairs of the existing stock.

25. The need was felt therefore to integrate into a single notion of "total" cost both the initial building cost and the sum of all the future expenditure required to maintain it or replace its parts over its expected lifetime. Attention was also devoted to the present level of expenditure and maintenance, to its significance in the overall house-building activities and to the main factors, both of a technical and economic nature, likely to affect it in the near future. The results of the enquiry carried out under the aegis of the Housing Committee and recently completed are briefly recalled below.

26. The present annual expenditure on current maintenance and major repairs in the countries participating in the enquiry covered a wide range; expressed in terms of the initial or replacement value of the building, this expenditure varies from a minimum of 0.5 per cent to a maximum of 2.0 per cent. However both extremes are to be considered exceptional, the lower considered insufficient and limited by the funds available for maintenance, the higher because of a considerable backlog of major repairs arising from the war and its aftermath or from prolonged housing shortages. In the majority of European countries, an annual expenditure of 1.0 - 1.5 per cent of the initial cost adjusted to current prices is, by present standards, considered adequate to maintain the dwelling in good conditions and to replace periodically those parts or components whose duration, either for technical or social considerations, is shorter than the expected life of the dwelling as a whole.

27. Irrespective of the absolute level of expenditure, between one-quarter and one-third of the total annual expenditure on maintenance is normally devoted to current maintenance. At the design stage, relatively simple and inexpensive arrangements can be made to facilitate the access to those internal parts (such as, for instance, pipes, valves, motors, etc.) exposed to frequent repairs or replacement or to facilitate the current maintenance of certain external finishes and fittings (roofing, flashings, external renderings, glazing, etc.). From

the point of view of the organization of maintenance operations, attention can be devoted to organizing "preventive" maintenance of those parts (such as, for instance, fuel burners, electric bulbs, etc.) subject to heavy wear and periodic replacement, to introducing the use of specialized light mechanical equipment and tools, or to improving the efficiency of the services responsible for carrying out emergency repairs.

28. The evidence submitted on the relationship between the age of the building and the actual level of maintenance expenditure is limited and for the time being not altogether convincing. In some countries, a slow but gradual increase of maintenance costs with age has been reported; in others, the level of maintenance costs is currently assumed to remain approximately constant over the expected lifetime of the building.

29. In spite of considerable differences of detail, it would appear possible to classify the main elements and parts of a building into a small number of categories or ranges of durability, which would be sufficiently accurate for the purpose of economic calculations. One of the main advantages of a simplified approach to the problem of durability of building elements would be to establish means of assessing and following trends in technological change in the building industry and in housing standards, especially with regard to the effect of introduction of short-life materials or more elaborate services and equipment.

30. From the evidence submitted by the few countries reporting such data, the present rate of demolition is well below what could be reasonably expected from current estimates of the average lifetime of the dwelling stock; in no case is this rate higher than 0.3 per cent per year. Although the reasons for this situation are well known, the consequences of the backlog in demolition on the accelerated ageing of the stock and on the level of future replacement needs cannot be fully measured from present statistical evidence, although it is already possible to foresee that, in order to face this situation, the share of house building activity devoted to the replacement of obsolete dwellings will have to be increased in most countries in the near future.

31. In spite of the difficulties pointed out above, it appears feasible and indeed desirable to plan future maintenance costs although future changes in technology may invalidate the initial estimate. The examples provided in the report illustrate some of these methods and stress the real benefit which could be derived from a better knowledge of the future level of maintenance costs, from the point of view both of the individual investor and of the general economy.

32. A further step in the direction of a more comprehensive approach to the economic study of housing costs is the integration of the separate notions of initial cost, future maintenance and running costs and lifetime of the building and its individual parts into a single concept of "total" or "final" cost. The enquiry shows that data on the durability of building elements and on the present level of maintenance costs are sufficiently accurate to provide a basis for such calculations, and that different methods can be used which lead substantially to the same results. The choice of the most suitable method depends of course on the purpose of the exercise and on the accuracy of the data available. But whatever the method actually used, the results of such calculations should be an important factor in guiding policy-making bodies in the choice of the type of investment most favourable within the context of the economy as a whole.

Some special problems of under-developed countries

33. The studies carried out under the aegis of the Housing Committee reflect quite naturally the preoccupations of the European countries which, together

with the United States of America, are its constitutional members. Political, economic, technical and social conditions vary a great deal within Europe as so do many of the problems which governments have to face in elaborating and implementing their policies in the field of house-building. Still greater differences arise, however, if one compares under-developed countries to the majority of European countries.

34. The first and most striking difference concerns the present level of income: under-developed countries have a national per capita income ten to twenty times smaller than industrialized countries in Europe and America. The part of that income which can reasonably be devoted to gross domestic fixed capital formation is generally lower in under-developed countries than in industrialized countries, perhaps in the order of one-half. It is also reasonable to expect that developing countries shall assign higher priority within capital formation to productive investments required to increase their overall output.

35. Construction taken in its widest sense, i.e. including civil engineering and public works, may represent a considerable part of investment; but funds for investment in residentail construction (housing and related facilities) shall have to compete with other "non-productive" investments. Many a technical solution which has proved satisfactory in an industrial country may be inapplicable in an under-developed country if the sheer volume of house construction is below a minimum threshold.

36. Needs, on the other hand, if measured by objective standards and not in terms of effective demand will continue to expand at an increasing rate as a consequence of the same factors mentioned in paragraph 4, some of which, however, might be even more accentuated in the case of under-developed countries. The gap between housing requirements and the capacity of the national economy to fulfill them is such that bold policy decisions will have to be taken if a constructive, rather than a negative, approach has to set in.

37. Some of the options to be taken might result in assigning priority to environmental sanitation, servicing and in general the basic infra-structure of development, while limiting to a strict minimum the expenditure on housing of adequate standards. In other cases it may be decided to encourage large programmes of aided self-help construction, either in rural or in urban areas, or in both. The problems of the adequate development of the building industry (or, in some cases, of its creation from nil), and of the corresponding expansion of the physical means required to carry out long-term building programmes, will be radically different in either case.

38. Some of the conditions prevailing in the under-developed countries may represent serious obstacles to the application of modern industrial techniques. Among these one could mention the prevalence of rural population, the low average density of population, the great distances separating large and small urban centres, the lack of adequate transport networks and transport facilities or the insufficient knowledge of the potential development value of local resources.

39. Another fundamental difficulty of many under-developed countries derives from the small present capacity of the local market. In many cases, only an inter-regional approach could warrant the setting up of some industries such as steel, cement, aluminium, etc., which could contribute to the local production of building materials.

40. For the time being in several under-developed countries, many building materials are imported from abroad and consume a sizeable proportion of very scarce foreign exchange. Small industries capable of producing some of the materials and components currently used in building (cement blocks, hollow bricks, floor wall and roof tiles, simple sanitary equipment, parts of the electrical installation, joinery, hardware, etc.) could usefully be set up to cater for the local market.

41. A considerable effort at standardization is vital in this respect, since for many years to come many of the under-developed countries shall have to continue to depend of foreign imports. The problem of inter-changeability of components and of their future replacement, which has been dealt with in one of the studies referred to above, may become a very serious one, as a consequence of recently acquired independence or of severage from a dominant metropolitan market.

42. The concentration of the quantitative housing shortage round the main urban areas may, on the contrary, represent an inducement to setting up plants producing relatively highly industrialized components, which could be delivered and assembled within a small radius. Technical "know-how" is nowadays available in many European countries and most of the basic technological and organizational problems have already been solved. However, some of these processes require rather heavy investment and can only be justified by a long-term and continuous programme of construction.

43. Some of the more advanced building methods, using for instance large-size prefabricated concrete components, may result in savings of total manpower, and especially a reduction of the requirements of traditional skills. The transfer of the operation from the building site to the factory, however, will create the need for new skills and for better organization and control of the whole building process. Vocational training programmes which should take these perspectives into account, could be formulated only after the adoption of coherent long-term policies.

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SUMMARY

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TECHNICAL AND ECONOMIC ASPECTS OF THE INDUSTRIALIZATION OF BUILDING

By The Steel, Engineering and Housing Division,
Economic Commission for Europe

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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TECHNICAL AND ECONOMIC ASPECTS OF THE INDUSTRIALISATION OF BUILDING

A paper prepared and submitted by the Steel, Engineering and Housing Division, Economic Commission for Europe

The Housing Committee of the Economic Commission for Europe has devoted its attention over the last fifteen years to the complex problems of technical and economic policies in the field of building in general, and more particularly of house-building in Europe.

It is felt that some of the problems to be faced and the approach followed in their solution may be of interest to developing countries.

The general expansion of quantitative housing needs, the trend towards urbanisation, and the general increase in building costs, are all factors contributing to making economies in building costs one of the main problems of government housing policies and, in a sense, an important aspect of economic development.

The Committee has undertaken three major studies intended to throw light on the main components of actual house-building costs and on the factors affecting them:

(a) An enquiry on house-building costs, covering some sixty building sites in nine European countries, and a wide range of building materials and building methods - from purely traditional construction to the most recent examples of full-scale prefabrication of room-size wall and floor panels.

(b) The enquiry on house-building costs confirmed that building materials represent up to, and sometimes even more than 60 per cent of the total cost of construction. Attention was therefore devoted to the possibility of reducing this item of cost, and in particular to the benefits to be derived from mass-production. A special study was undertaken on the effect of repetition on the production cost of building materials and components, and more specifically on how production costs of selected components currently used in house construction may be, and actually are reduced through a systematic limitation of the number of models produced, or an increase in the length of production runs.

(c) A study of the problem of the lifetime of a building and of the expenditure on maintenance and repairs. So far in planning housing development, only the initial cost of a building has been taken into account, but whatever the expected economic or social life of a building may be, some periodic expenditure will be required to maintain it in conditions suitable for the use for which it has been designed. The need was felt, therefore, to integrate into a single notion of "total" cost, both the initial building cost and the sum of all the future expenditure required to maintain it or replace its parts over its expected lifetime.

The provisional conclusions of these three enquiries are discussed, and their possible application to some of the special problems of under-developed countries.

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КОНФЕРЕНЦИЯ ОРГАНИЗАЦИИ ОБЪЕДИНЕННЫХ НАЦИЙ
ПО ВОПРОСУ О ПРИМЕНЕНИИ НАУЧНЫХ И ТЕХНИЧЕСКИХ ЗНАНИЙ
ДЛЯ УДОВЛЕТВОРЕНИЯ ПОТРЕБНОСТЕЙ МЕНЕЕ РАЗВИТЫХ РАЙОНОВ

ПУНКТ ПОВЕСТКИ ДНЯ: D.7

ЕВРОПЕЙСКАЯ
ЭКОНОМИЧЕСКАЯ КОМИССИЯ
ООН, ЖЕНЕВА

ПЕРСПЕКТИВЫ МИРОВОГО ПРОИЗВОДСТВА СТАЛИ
ВЫБОР МЕТОДОВ

Составлено Европейской Экономической Комиссией ООН

Документы, составленные для Конференции Организации Объединенных Наций по вопросу о применении научных и технических знаний для удовлетворения потребностей менее развитых районов, служат в качестве рабочих документов для этой Конференции. Они опубликованы в том виде, в каком были представлены их составителями, и их содержимое и выраженные в них мнения принадлежат их составителям (см. примечания на оборотной стороне).

ПРИМЕЧАНИЯ

1. Документы, включенные в число материалов, принятых для обсуждения на общих сессиях, будут в распоряжении делегатов Конференции на следующих официальных языках Организации Объединенных Наций: русском, английском, испанском и французском.

2. Документы, включенные в число материалов, принятых для обсуждения на специализированных сессиях, будут в распоряжении делегатов Конференции только на одном из этих официальных языков.

3. Резюме всех документов в том виде, в каком они были представлены их составителями, будут в распоряжении делегатов Конференции на следующих официальных языках Организации Объединенных Наций: русском, английском, испанском и французском.

4. До открытия Конференции документы и резюме не будут выпущены для общего распространения. Они будут опубликованы заблаговременно только в ограниченном числе экземпляров и исключительно для правительственных делегаций и других правомочных участников. Последующие опубликование и рассылка трудов Конференции будут обеспечены в соответствии с практикой Организации Объединенных Наций, как это установлено ее Издательским комитетом.

ПЕРСПЕКТИВЫ МИРОВОГО ПРОИЗВОДСТВА СТАЛИ
ВЫБОР МЕТОДОВ

Для каждой страны, производящей черные металлы, правильный технико-экономический выбор способа производства стали имеет большое хозяйственное значение как при строительстве новых, так и при реконструкции и расширении действующих металлургических заводов.

В Секретариате ЕЭК ООН недавно закончено исследование по сравнительной технико-экономической оценке существующих способов производства стали.

Изложение основных результатов этого исследования приводится ниже в весьма сокращенном объеме.

Прогнозы о наиболее вероятных способах производства стали, которые получат преимущественное развитие в ближайшем будущем, чрезвычайно затруднительны, так как с одной стороны, каждый из существующих способов из года в год совершенствуется, а, с другой стороны, при нынешнем развитии техники и колоссальном объеме проводимых научно-исследовательских работ могут появиться новые способы производства стали, дающие такие технико-экономические результаты, которые обеспечат исключительно быстрое распространение этих новых процессов.

Однако, согласно данным технической литературы за последние годы и другим сведениям, собранным для подготовки упомянутого исследования, следует считать, что в течение ближайших четырехпяти лет при строительстве новых сталеплавильных агрегатов основное внимание и предпочтение будет уделено установке кислородных конвертеров типа ЛД и Кальдо.

Так например, во Франции в период 1960-1965 гг. мощность конвертеров этого типа увеличится примерно на 6 млн.т., а мощность электропечей - приблизительно на 1 млн.т. За этот же период производство стали в мартеновских печах не возрастет, а в томасовских конвертерах даже несколько уменьшится.

В странах ЕОУС было намечено, что в 1960 г. из общих капиталовложений в сталеплавильное производство в размере 357 млн. долларов, 285 млн. будет затрачено на сооружение кислородных конвертеров и при общем приросте производства стали в 13,2 млн.т.

мощность кислородных конвертеров увеличится на I6,92 млн. т., а мощность томасовских конвертеров и мартеновских печей уменьшится соответственно на 4,33 и 0,26 млн.т.

В Японии в период I960-I970 гг. предполагается увеличение выплавки стали с 22-х до 48 млн.т. Из этого общего прироста выплавки в 26 млн.т. почти 22 млн.т. придется на долю кислородных конвертеров и около 4 млн.т. - на долю электрических печей; что же касается мощности мартеновских печей, то она фактически не изменится.

В Соединенном Королевстве за период I960-I965 гг. выплавка стали увеличится с 25 до 34 млн.т., причем этот прирост будет осуществлен, главным образом, в кислородных конвертерах типа ЛД и Кальдо.

Аналогичные перспективы имеются в ряде других стран. На основе имеющихся данных можно считать, что суммарная мировая мощность кислородных конвертеров разных типов увеличится в I965 г. до I00 млн.т. и к I970 г. по некоторым прогнозам до 200 млн.т. в год. Такие планы развития производства стали в кислородных конвертерах позволяют сделать следующие обоснованные заключения:

a/ новых бессемеровских цехов строить не будут;

b/ маловероятно, чтобы строились новые томасовские цехи даже с продувкой смесями, не содержащими азота;

c/ только в обстоятельствах, вызванных особыми специфическими условиями, возможно строительство новых мартеновских цехов со стационарными печами; строительство мартеновских печей, а также печей, работающих на холодной завалке не имеет перспектив, поскольку производство стали другими способами позволяет получить лучшие технико-экономические результаты.

Однако при выборе способа производства стали следует, по крайней мере в настоящее время, учитывать такое преимущество мартеновского производства как его большую гибкость в отношении использования металлолома, а также еще не исчерпанную возможность дальнейшего сокращения эксплуатационных издержек и повышения производительности печей в результате применения кислорода;

d/ в новых сталеплавильных цехах будут строиться кислородные

конвертеры различных типов и дуговые электрические печи. Несомненно будет произведена полная или частичная замена существующих томасовских и бессемеровских конвертеров кислородными конвертерами и замена существующих мартеновских печей /прежде всего работающих на холодной завалке/ - электрическими печами или кислородными конвертерами;

е/ строительство новых роторных установок на ближайшие годы не намечено. Из двух типов вращающихся сталеплавильных агрегатов будут повидимому строиться лишь конвертеры Кальдо.

Менее ясен вопрос о том, какой из двух сталеплавильных процессов в кислородных конвертерах или в электрических печах - и в каких именно условиях окажется предпочтительным и какой из них получит преимущественное развитие.

Совместная работа /по принципу дуплекс/ электрических печей, работающих на холодной завалке и, почти исключительно, на скрапе с кислородными конвертерами, переплавляющими ограниченные количества металлолома, может быть выгодной, т.к. это позволяет проплавлять шихту, состоящую из любых соотношений чугуна и металлолома при достаточной гибкости этого метода в отношении сортамента выплавляемых сталей.

Вышеизложенные соображения о перспективах развития различных способов производства стали основаны на следующих проверенных производственным опытом технико-экономических данных:

I. Удельная производительность /под которой понимается производительность, отнесенная к тонне емкости сталеплавильного агрегата/ кислородного конвертера составляет примерно 8-I0 тыс.т. в год, а мартеновской печи, работающей даже с применением кислорода - до I тыс.т. в год. При этом сталеплавильный цех, состоящий из конвертеров, занимает значительно меньшую территорию, чем мартеновский цех такой же производительности.

2. Производительность труда /в тоннах на I рабочего в год/ в конвертерном цехе в I,5-2,5 раза выше, чем в мартеновском.

3. Кислородные конвертеры успешно перерабатывают чугуны, содержащие фосфор в количестве от десятых долей до 2,2%, тогда

как в стационарных мартеновских печах количество фосфора в чугуне ограничено 0,3-0,4%, а качающиеся мартеновские печи, обычно работающие с пониженными технико-экономическими результатами, перерабатывают чугуны, содержащие не более I,7-I,8% фосфора.

4. Накопленный опыт работы опроверг прежние утверждения о существенной ограниченности сортамента сталей, выплавляемых в кислородных конвертерах, по сравнению со сталями мартеновского производства. Фактически по сортаменту выплавляемого металла, кислородный конвертер может успешно конкурировать с мартеновской печью.

5. Содержание фосфора и серы в кислородной конвертерной стали не выше, чем в мартеновской, а при вводе в струю кислорода порошковой извести - даже ниже. При работе на чистом кислороде конвертерная сталь содержит 0,002-0,004% азота, то есть в несколько раз меньше, чем мартеновская.

По содержанию кислорода и водорода конвертерная и мартеновская стали равноценны. Механические свойства конвертерной стали не ниже, чем мартеновской, а в отношении пластичности конвертерная стальзначительно лучше мартеновской.

6. При равной производительности емкость конвертера примерно в IC раз меньше емкости мартеновской печи, благодаря чему конвертер является агрегатом гораздо более гибким как в отношении выполнения заказов по обширному сортаменту сталей, так и для подачи стали на машины непрерывной разливки меньшими порциями, что обуславливает установку более легких машин и более высокую степень их использования.

7. Анализ данных для ряда стран показал, что при одинаковом соотношении чугуна и металлолома в шихте капиталовложения на строительство конвертерного цеха составляют 70-75% затрат на строительство мартеновского цеха.

8. Себестоимость конвертерной стали примерно на 5% ниже, чем мартеновской.

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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item : D.7

United Nations
Economic Commission for Europe

THE PROSPECTS FOR WORLD STEEL PRODUCTION : THE CHOICE OF PROCESSES

By The United Nations Economic Commission for Europe

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THE PROSPECTS FOR WORLD STEEL PRODUCTION; THE CHOICE OF PROCESSES

by

the United Nations Economic Commission for Europe

A detailed economic comparison of the results obtained by means of various steel-making processes widely used in industry would appear to show that, when new steel plants are built in the next few years, preference will be given to the installation of oxygen converters of the LD and Kaldo types. There will also be a considerable expansion in the production of electric steel. On the basis of the available data concerning long-term plans for the development of steel production throughout the world, it may be estimated that the total capacity of oxygen converters of various types will rise to 100 million tons by 1965 and, according to some forecasts, to 200 million tons by 1970. The following conclusions may be drawn from these plans for the development of oxygen converter steel production:

(a) No new acid Bessemer shops will be built;

(b) There is little probability that new bottom-blown Thomas converter shops will be built, even for blowing with nitrogen-free mixtures;

(c) Only in special circumstances will the construction of new open-hearth shops with fixed furnaces be possible; the construction of tilting open-hearth furnaces and of shops based on cold-charged, open-hearth furnaces is unlikely;

(d) Oxygen converters of different types and electric-arc furnaces will be built in new steel shops;

(e) The construction of new Rotor installations in the near future is not envisaged. Of the two types of rotating steel-making vessels, only Kaldo furnaces are likely to be erected.

These forecasts of the future development of steel production are based on technical and economic data which are given in the report.

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